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**Geoscientific
Model Development
Discussions**

Interactive comment on "Efficient approximation of the incomplete gamma function for use in cloud model applications" *by* U. Blahak

Anonymous Referee #2

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Major comments.

This manuscript presents an efficient algorithm for calculating incomplete gamma functions. Incomplete gamma functions are widely applicable in cloud microphysics parameterizations (as well as other applications in geosciences). However, as the authors state, inefficiency of existing algorithms has precluded the wide use of incomplete gamma functions, or led to the use of crude approximations, in many cloud models. Thus, this paper should be of interest to the model development community and is appropriate for publication in Geoscience Model Development. The presentation is generally clear and the paper is well written. Overall, I recommend minor revisions to the manuscript before publication. Specific comments are given below.

1. The author discusses application of his algorithm to the problem of conversion to

hail based on the size limit for wet growth. However, there are many other processes for which incomplete gamma functions may be used in bulk models, and many of these processes involve conversion from one species to another (or 3-species conversion) using a fixed size or mass threshold for the conversion, and thus involve a variable "a" and fixed "x" in the computation of incomplete gamma function Y(a,x). On the other hand, the author states that "because for many process parameterizations in the context of bulk (moment) approaches the parameter a is fixed during subsequent evaluations.", but again this is not the case for many processes. The author also uses Harrington et al. (1995) as an example of a parameterization where there is a variable "x" but fixed "a" when using the incomplete gamma function, which is true for sublimation of ice concentration, but I believe their formulation for autoconversion actually uses a fixed "x" based on a size threshold for the conversion. Some discussion of this point is warranted, and how it might impact implementation of the algorithm (for example, precomputing parameters that only depend on "a" cannot be done in this case).

Specific minor comments.

1. p. 456. This is noted later in the manuscript, but I think the fact that solution to the incomplete gamma function is analytic for integer values of "a" should be first mentioned here when discussing previous application of the incomplete gamma functions. If "a" is equal to an integer value, then analytic solutions can be used for the microphysical process calculations, which is an important point.

2. p. 456. "In some cases where incomplete gamma functions have been used, simple analytical approximations very special values of a were employed. . ." More detailed description of this point is warranted. Did this involve integer values of "a", as discussed above in minor comment #1.

3. p. 456. "Or, as in Farley et al. (1989), the finite integrals otherwise resulting in incomplete gamma functions. . ." What is meant here by "finite integrals"?

4. p. 456-457. Many schemes also require incomplete gamma functions at a fixed "x"

and variable “a”, see major comment #1 above.

5. p. 457. “This is much more efficient and predictable compared to a non-equidistant table, where a search loop with a nested if-clause is necessary to find i.” A search loop is not required for all non-equidistant lookup tables, as long as the distance between tabulated values can be given by some functional form.

6. p. 460. Eq. (14). Why were these particular functional forms chosen for the c(a) parameters?

7. p. 462. Many microphysical processes require fixed “x” and variable “a”, so that pre-computation of the coefficients that vary with “a” will not be of use in this case. See major comment #1.

8. p. 464. “. . .but if subsequent evaluations at a certain fixed value of a are sought (which is often the case in cloud microphysics. . .” I disagree with this statement, many processes instead require fixed “x” and variable “a”, for example, processes dealing with a fixed size or mass conversion threshold. Again, see major comment #1.

Technical corrections.

1. p. 452-453. “. . .this ansatz may lead to the necessity to compute ordinary and incomplete gamma functions.” Suggest “. . .this ansatz may lead to the necessity of computing ordinary and incomplete gamma functions.”

2. p. 455. “. . .transformation of intermediate-dense graupel particles. . .”. “dense” should be “density”.

3. p. 460, last line. “beeing” should be “being”.

Interactive comment on Geosci. Model Dev. Discuss., 3, 451, 2010.